

Seasonal prediction of Arctic sea ice extent in the CFSv2

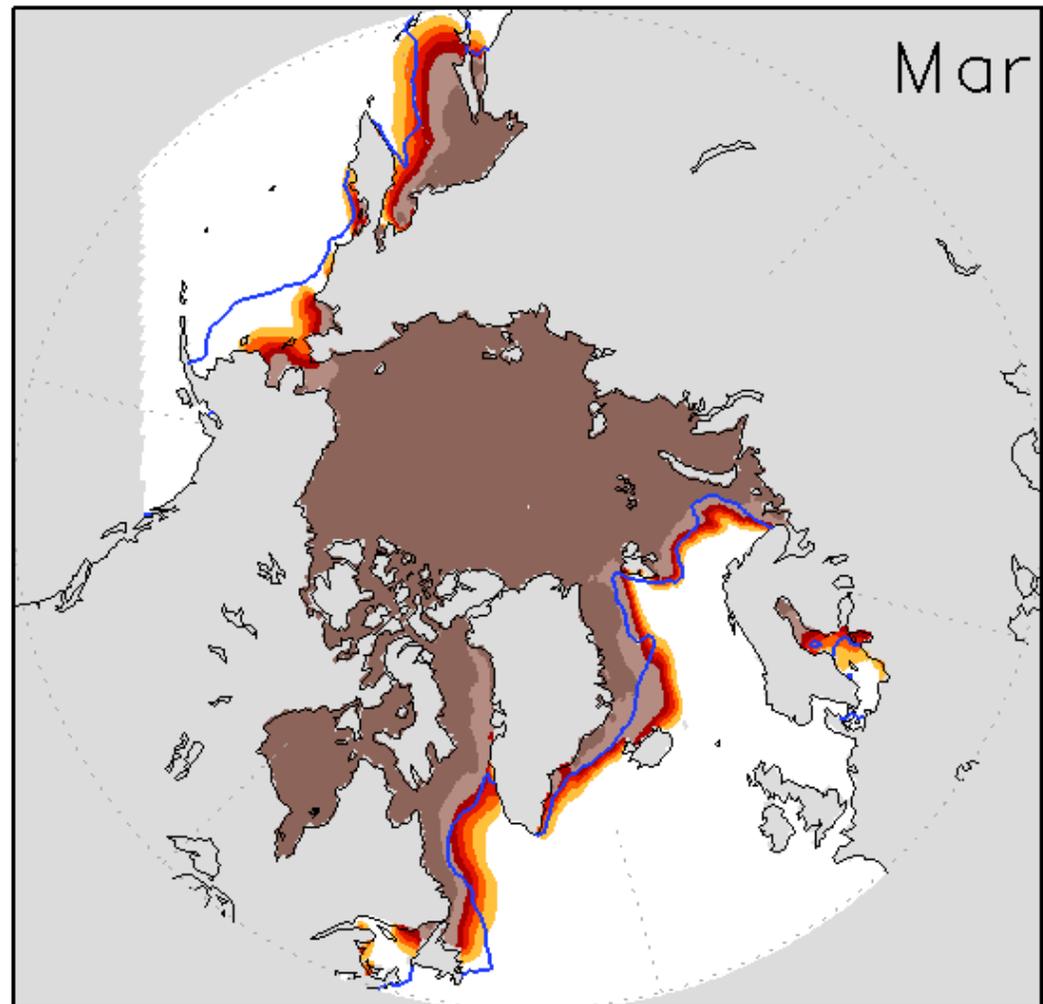
Wanqiu Wang, Mingyue Chen, and Arun Kumar

CPC/NCEP

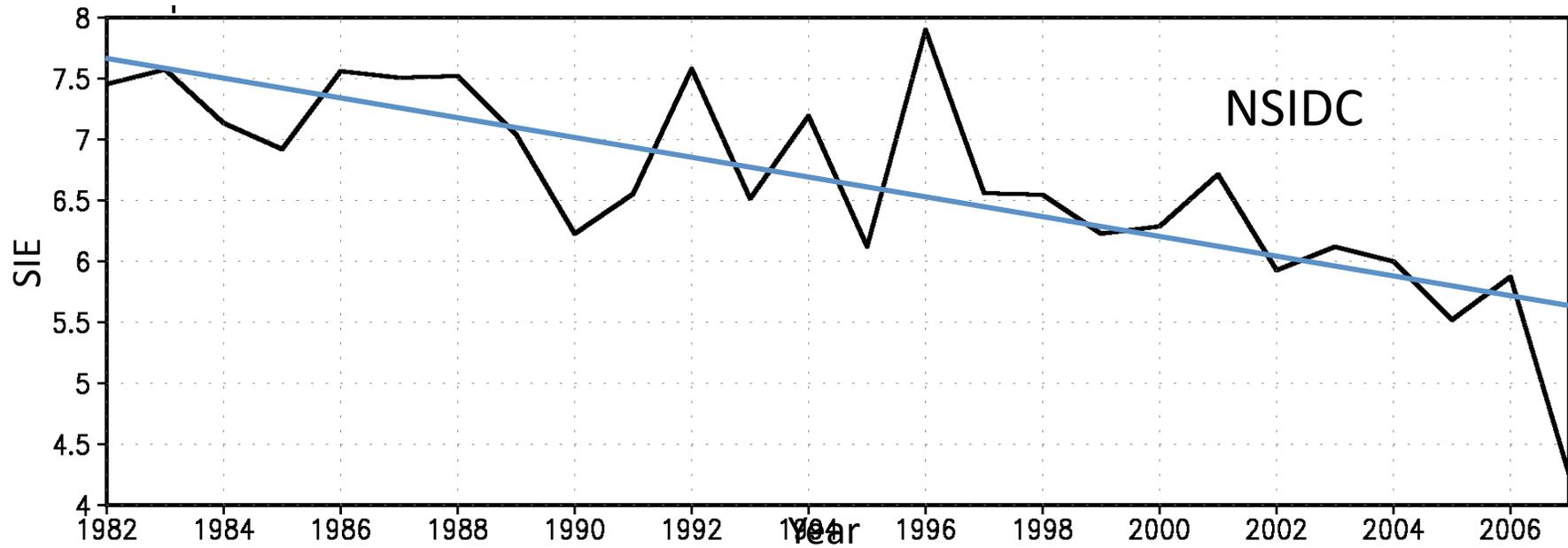
Sea ice extent (SIE): Sum of areas where sea ice concentration $> 15\%$

Shadings: CFSv2 concentration

Blue lines: NSIDC 15% concentration



Observed September sea ice extent (10^6 km^2)



Outline

1. Hidcast and observed data
2. Mean bias in CFSv2
3. SIE prediction skill and predictability
4. Factors affecting the prediction and predictability
 - Model errors
 - Initialization
5. Summary

Data

1. Forecast

- i) CFSv2 hindcasts from 1982-2007
- ii) 16 forecast ensemble members from each month
- iii) 10 target months

2. Observed data

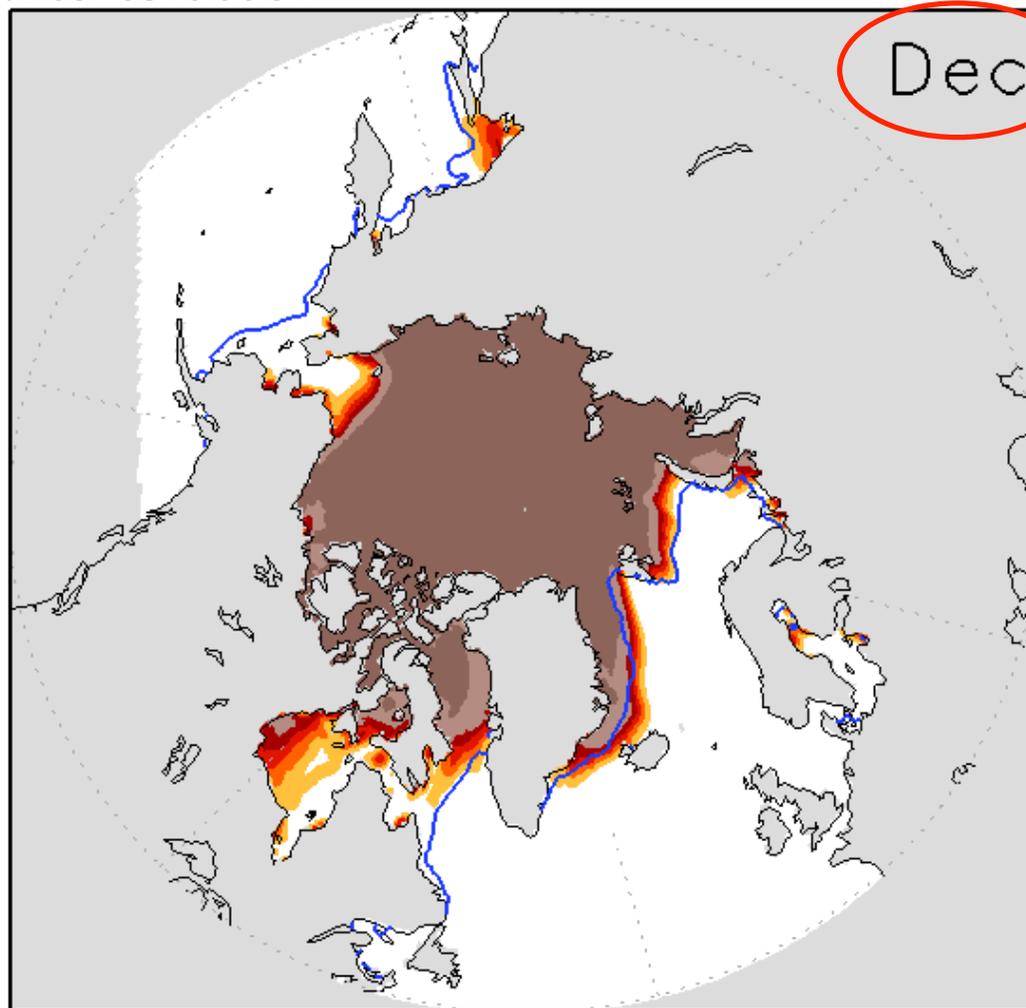
- i) NSIDC sea ice concentration
(Cavalieri, D., C. Parkinson, P. Gloersen, and H. J. Zwally. 1996)
- ii) NCEP sea ice concentration analysis

Mean bias in CFSv2

Sea ice coverage

Shadings: CFSv2 concentration at 5-month lead

Blue lines: NSIDC 15% concentration



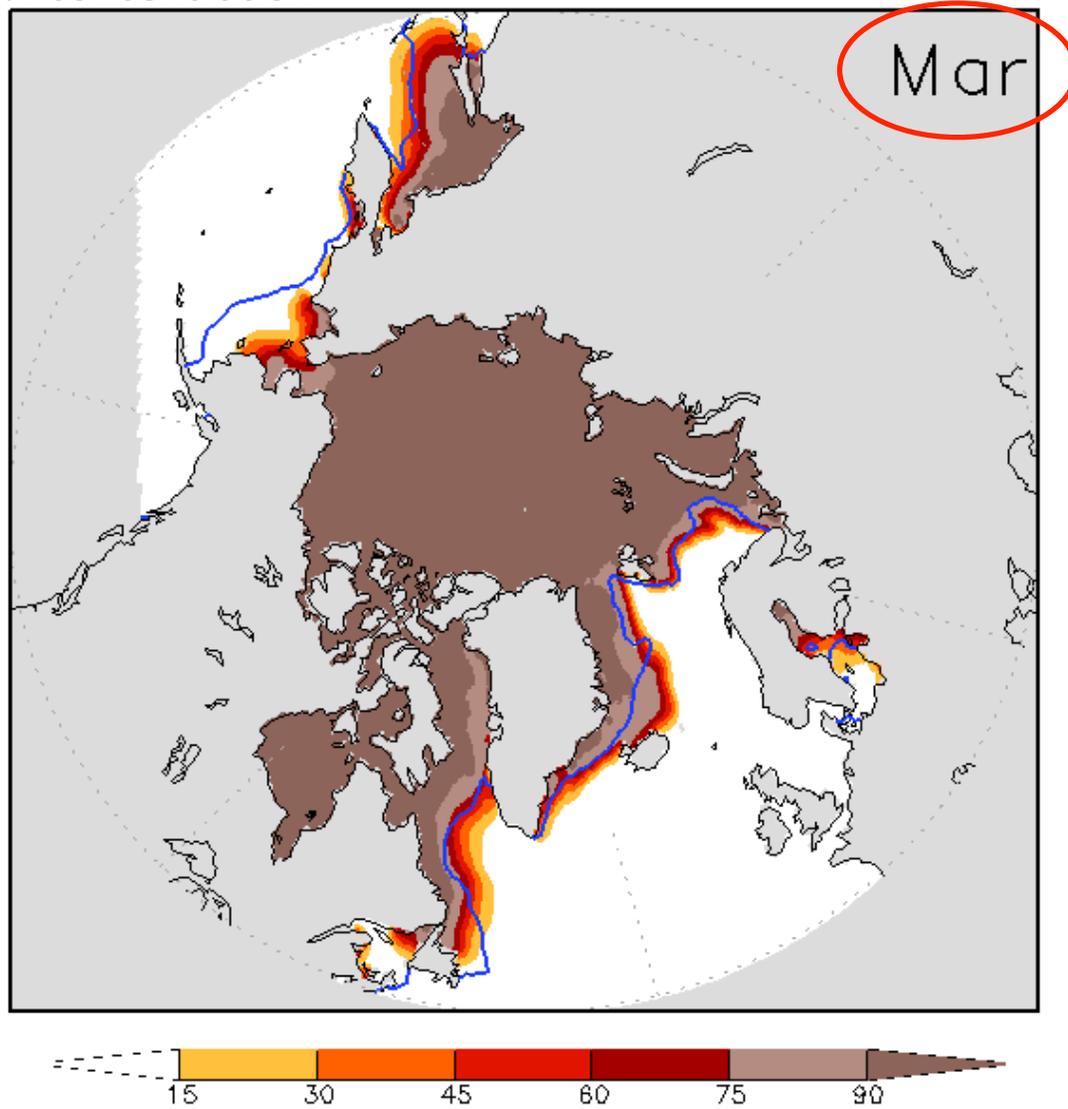
Target month



Sea ice coverage

Shadings: CFSv2 concentration at 5-month lead

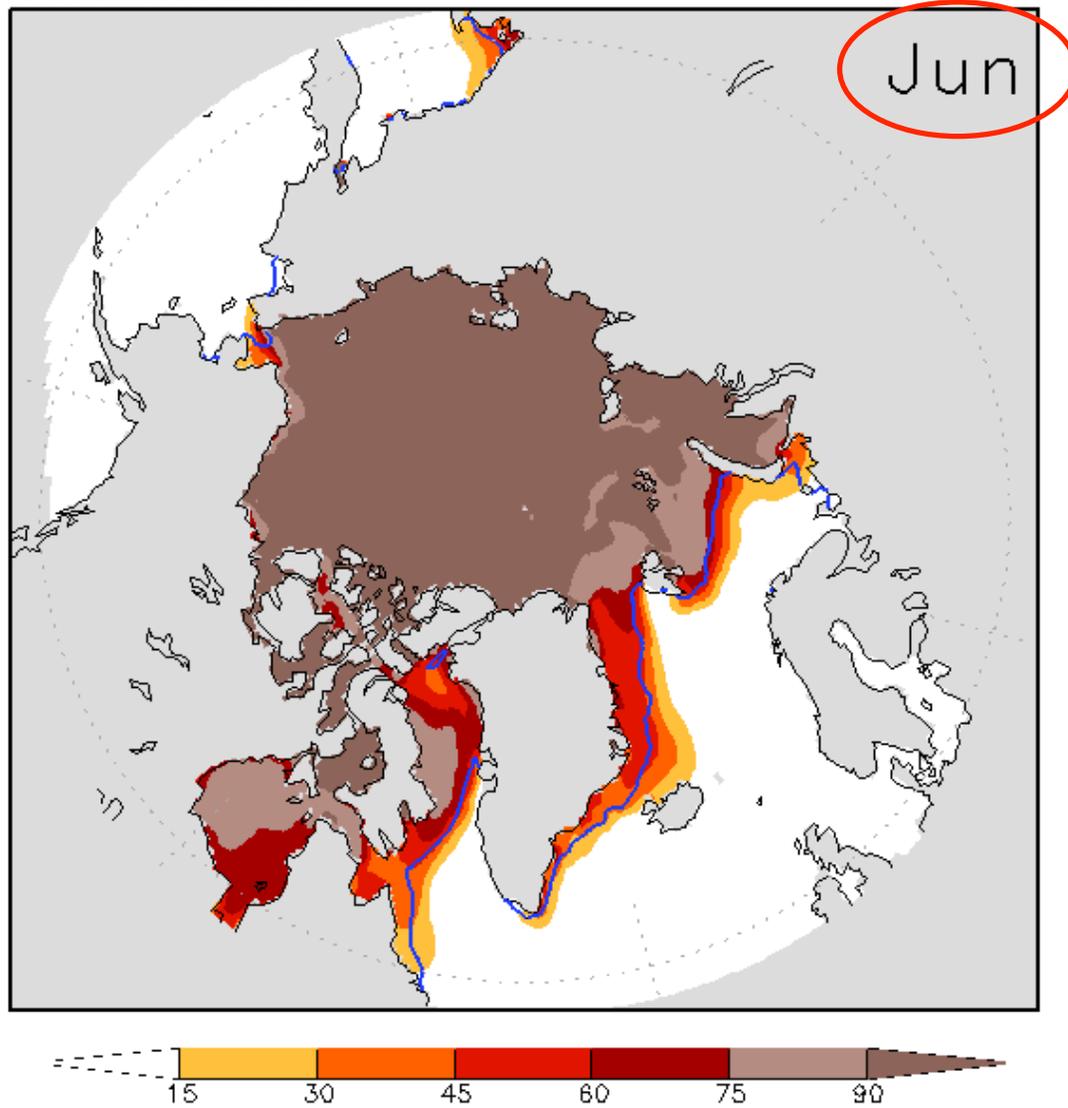
Blue lines: NSIDC 15% concentration



Sea ice coverage

Shadings: CFSv2 concentration at 5-month lead

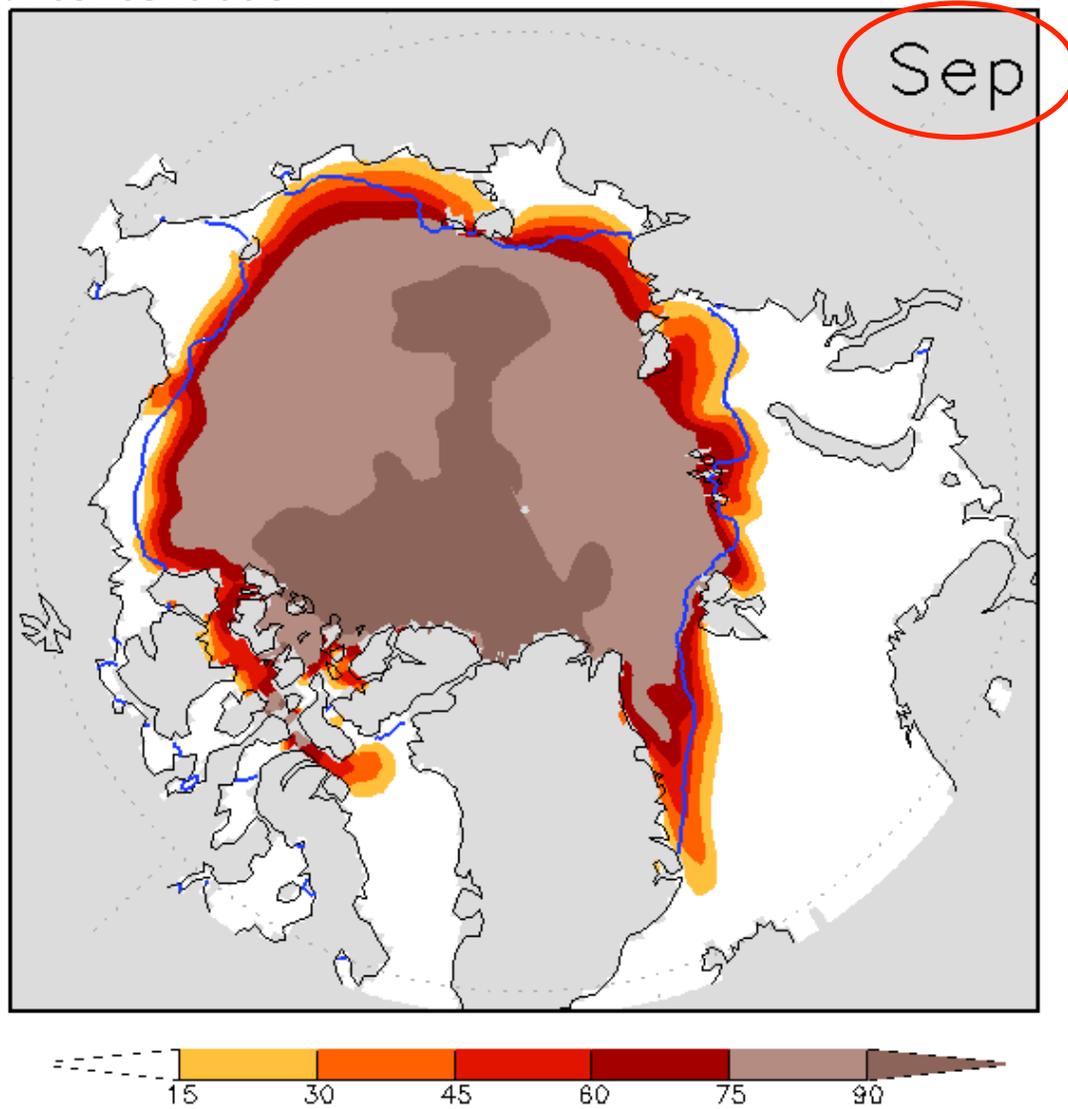
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Sea ice coverage

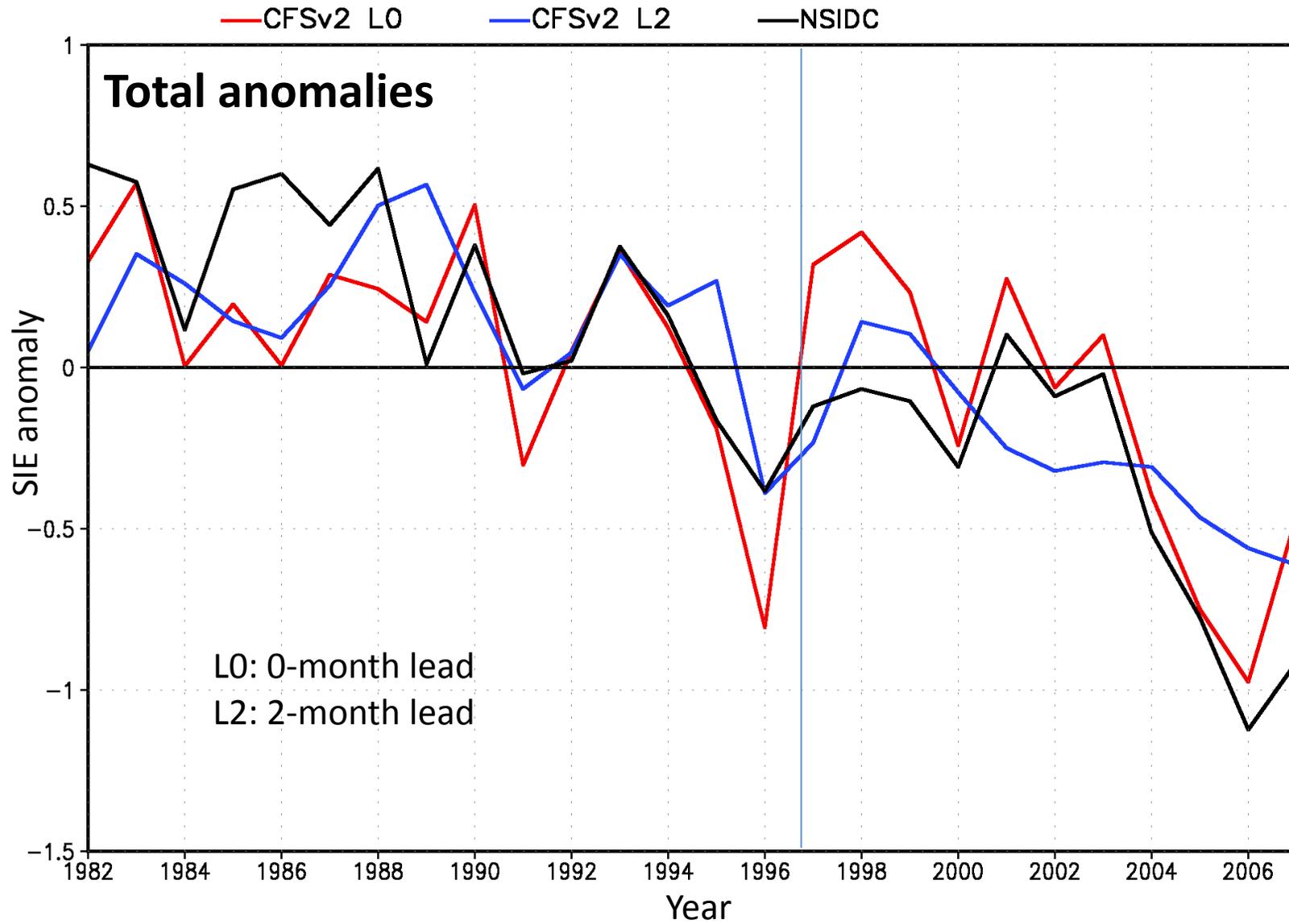
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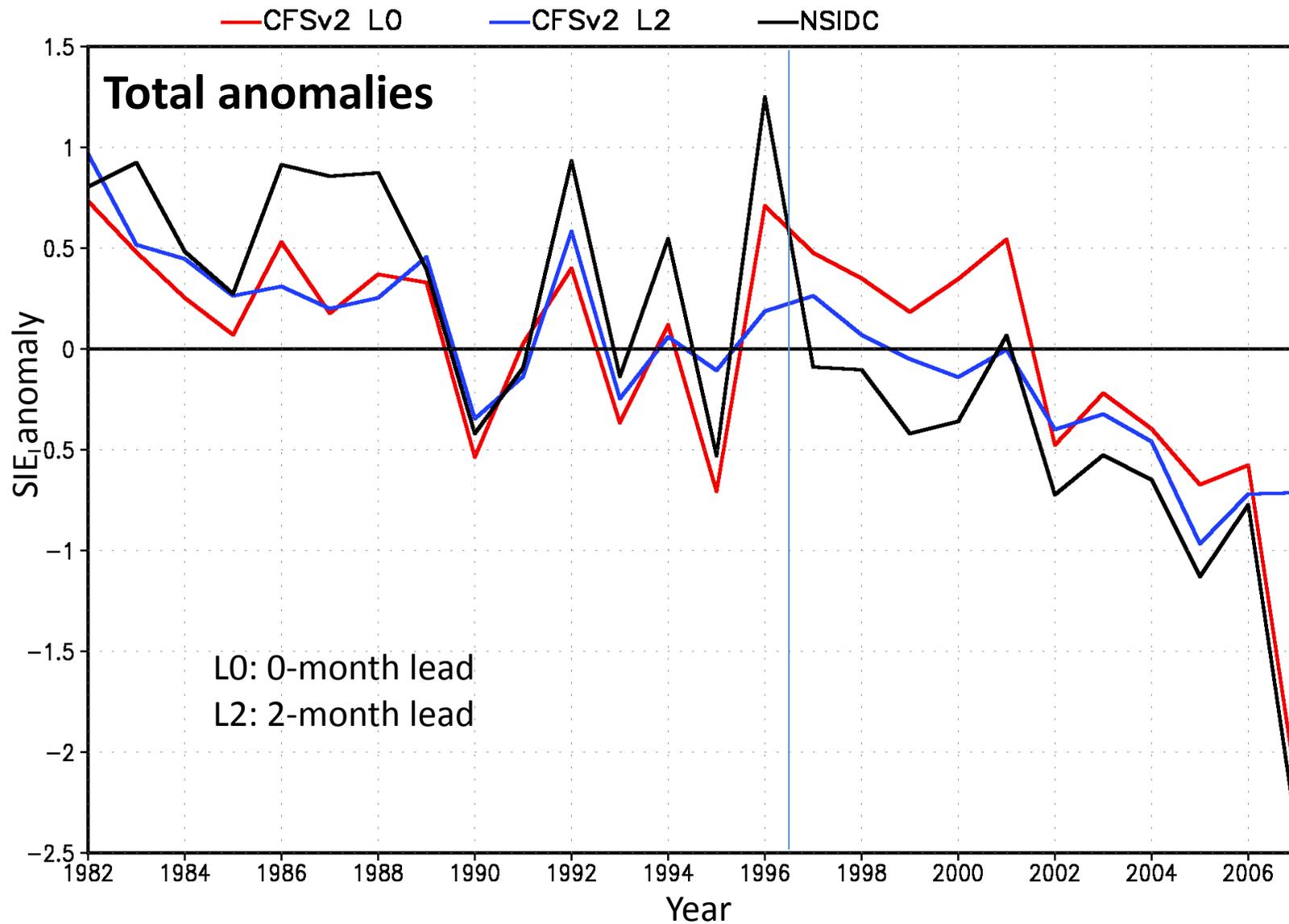


Prediction skill and predictability

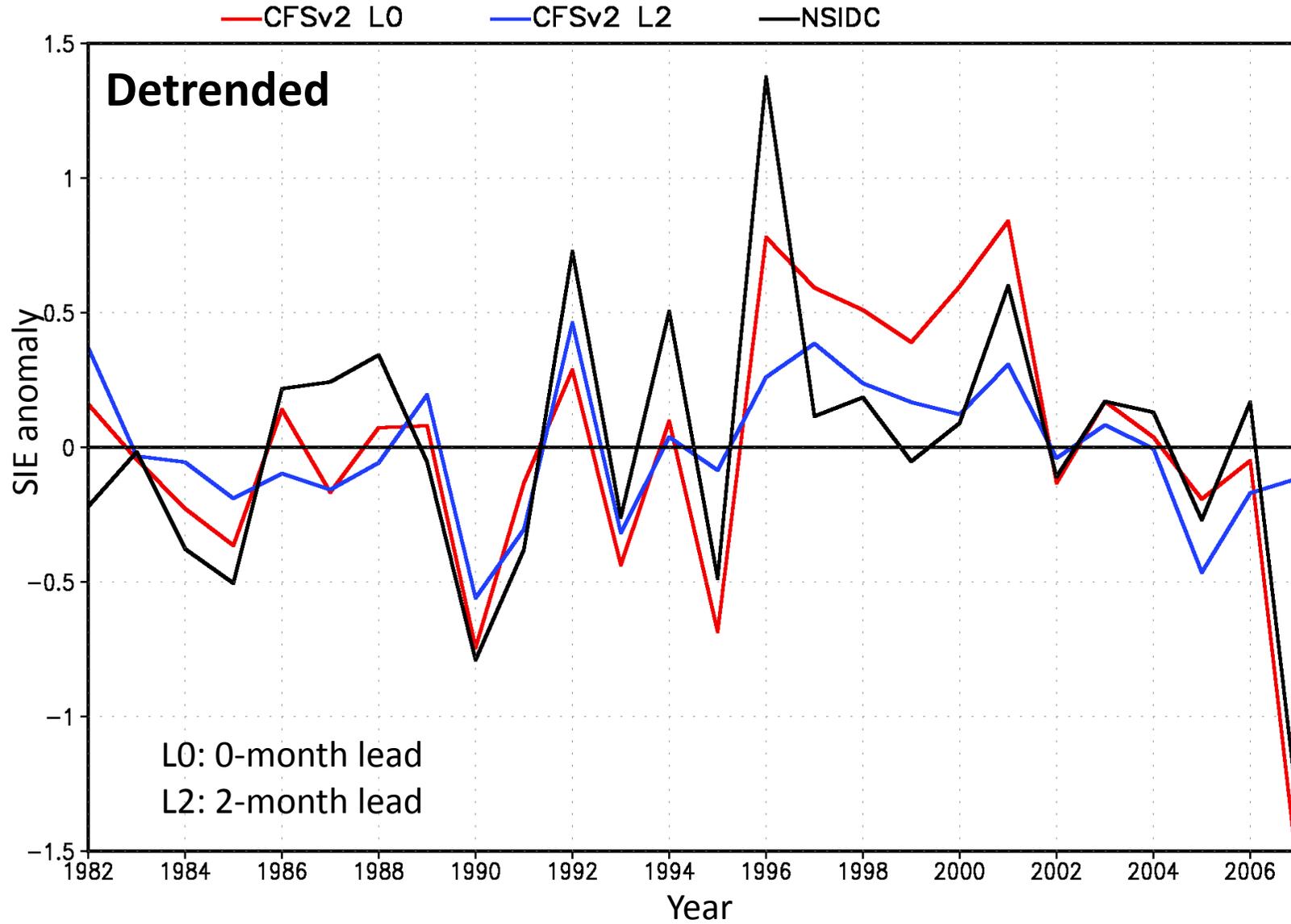
March sea ice extent anomalies (10^6 km^2)



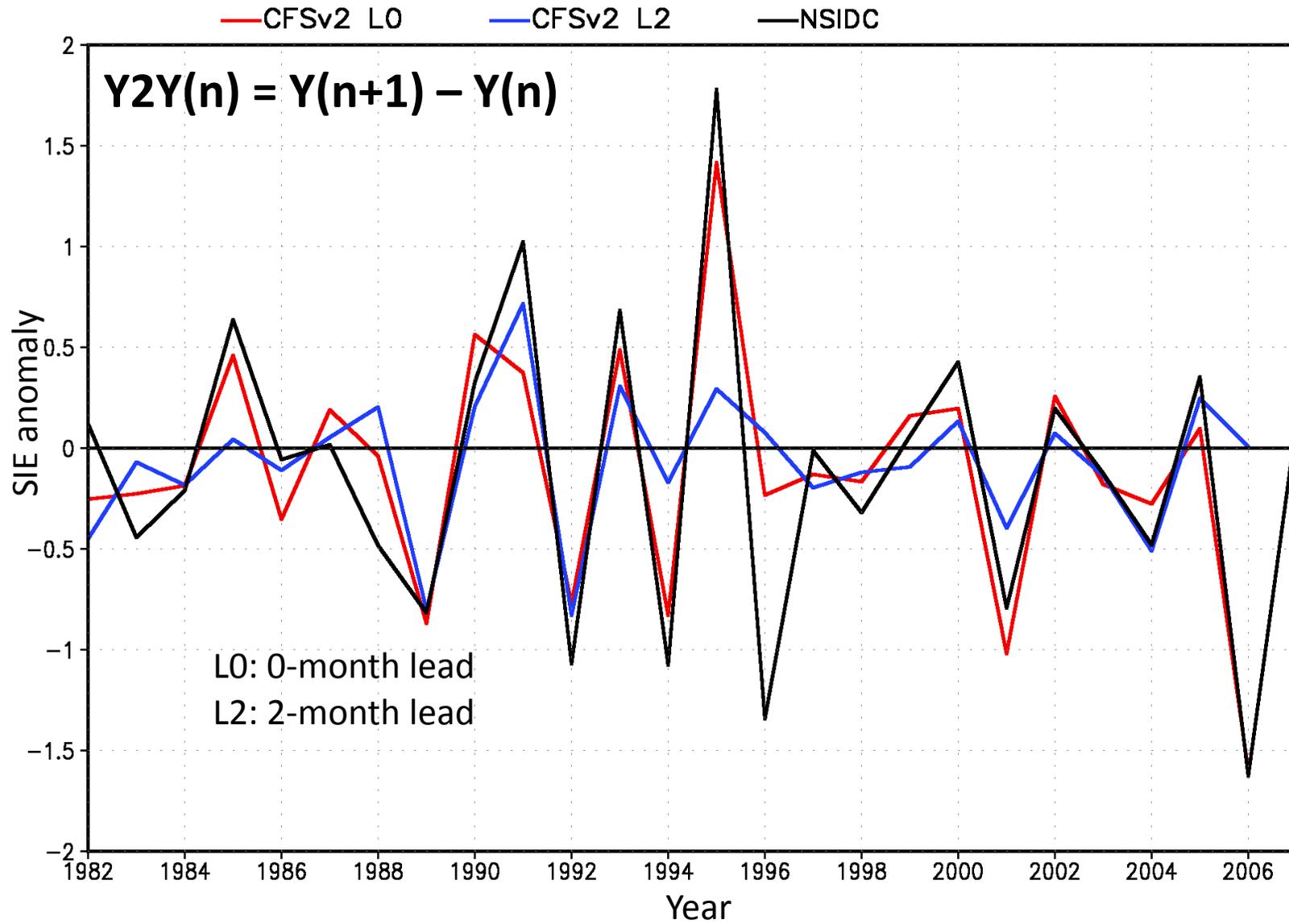
September sea ice extent anomalies (10^6 km^2)



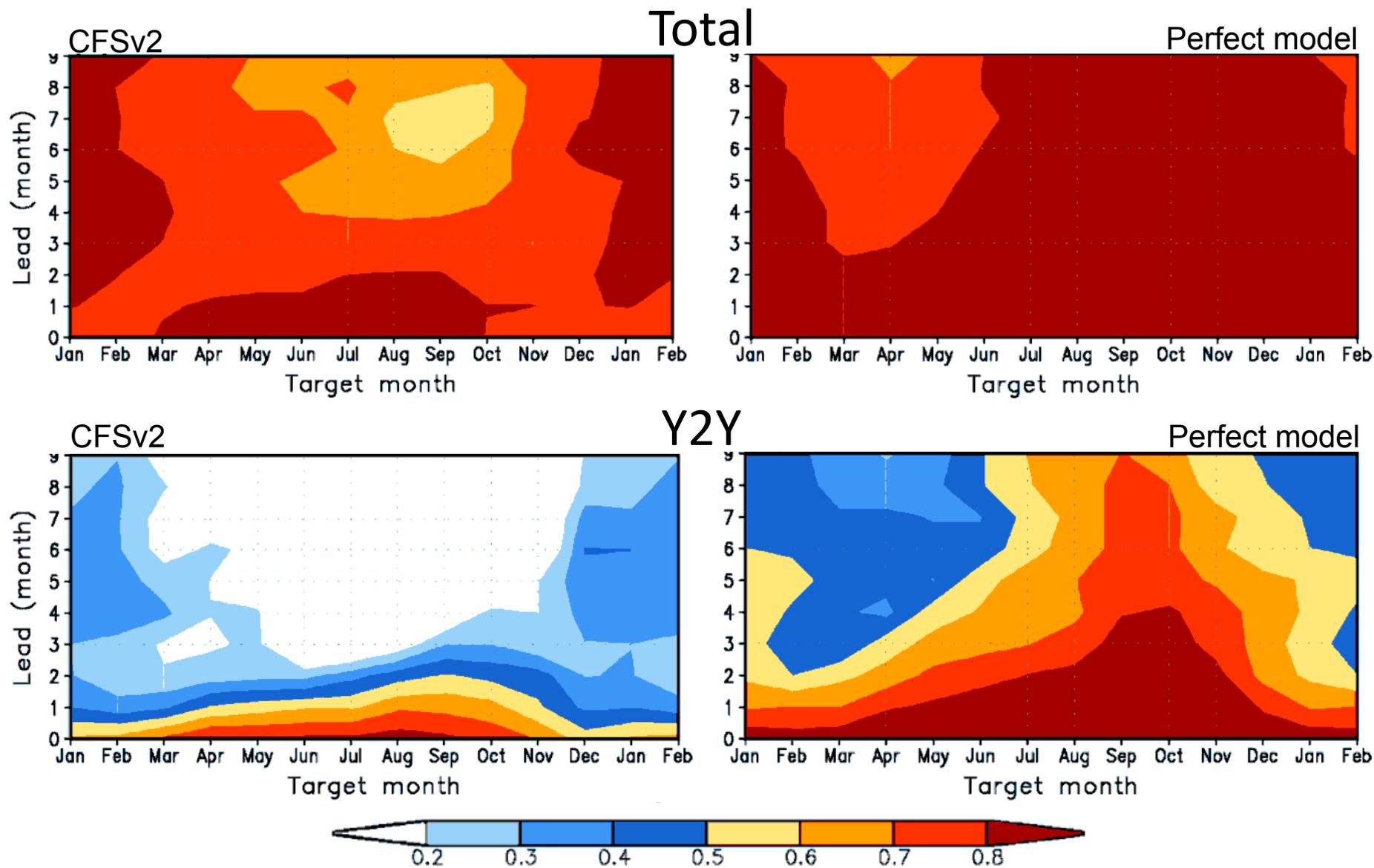
September sea ice extent anomalies (10^6 km^2)



September sea ice extent anomalies (10^6 km^2)



SIE anomaly correlation



Factors affecting the prediction and predictability

(1) Model errors

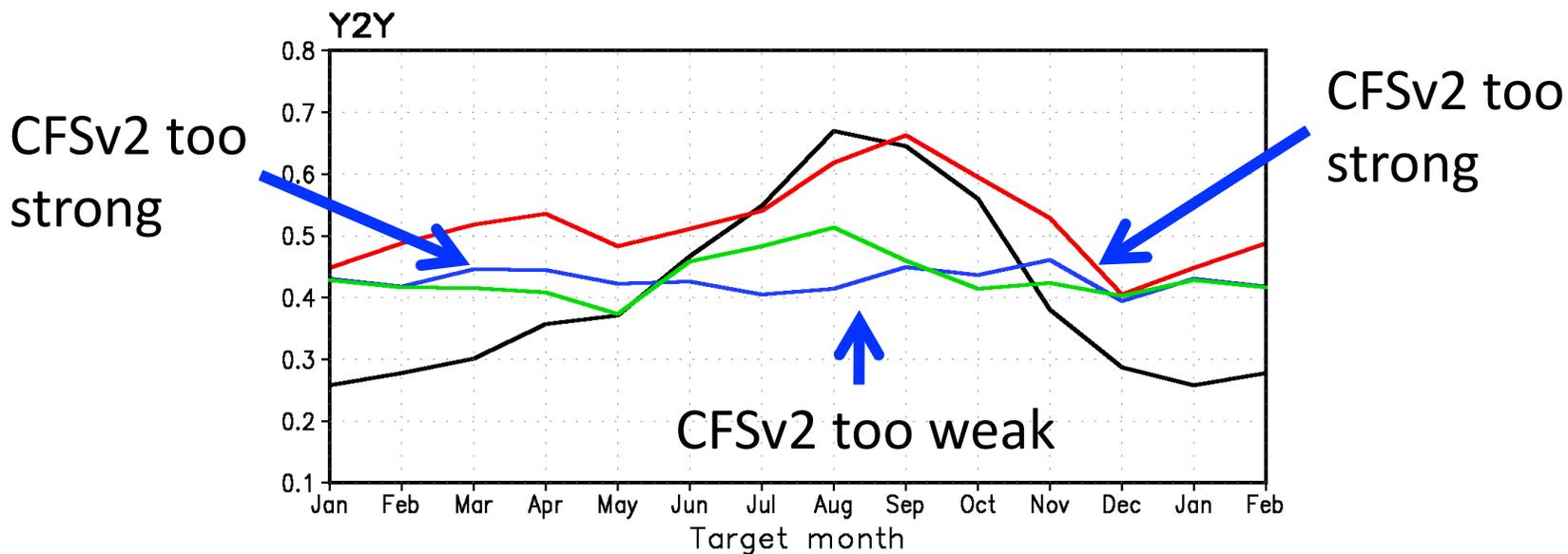
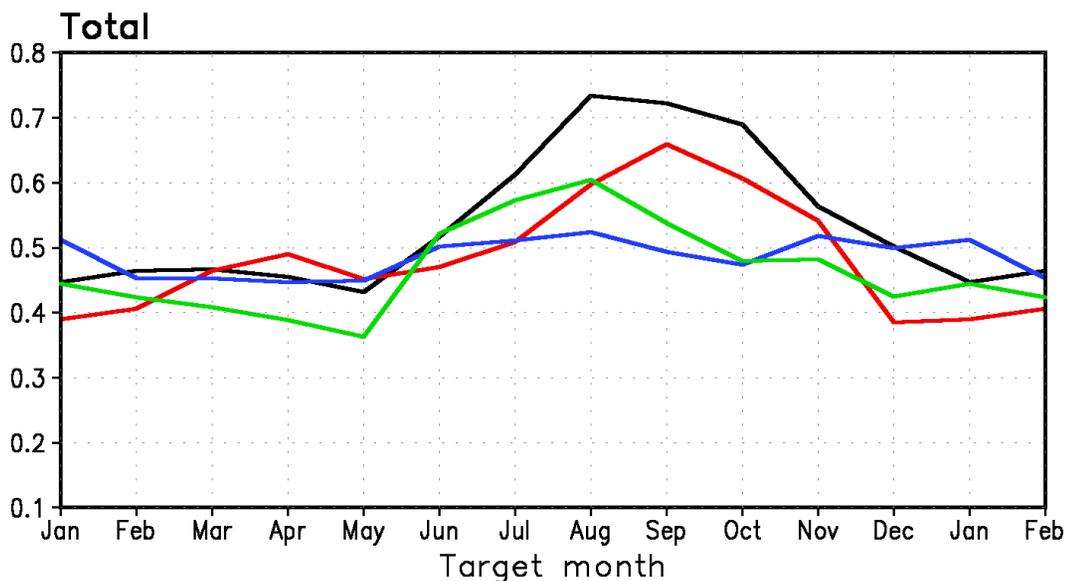
- i) Mean bias
- ii) Variability in the forecast system

(2) Initialization

- i) Sea ice coverage
- ii) Sea ice thickness

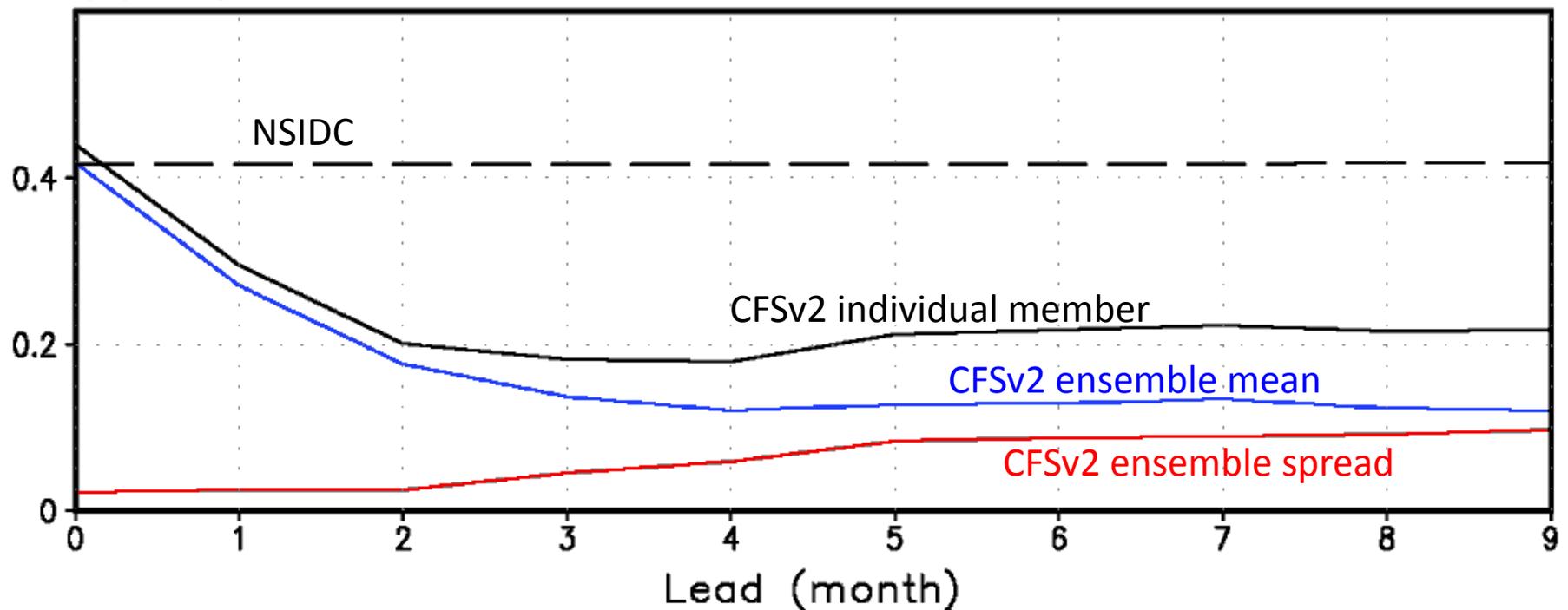
SIE standard deviation (10^6 km^2)

— CFSv2 L0 — CFSv2 L2 — CFSv2 L5 — NSIDC



Standard deviation and spread of Y2Y (10^6 km^2)

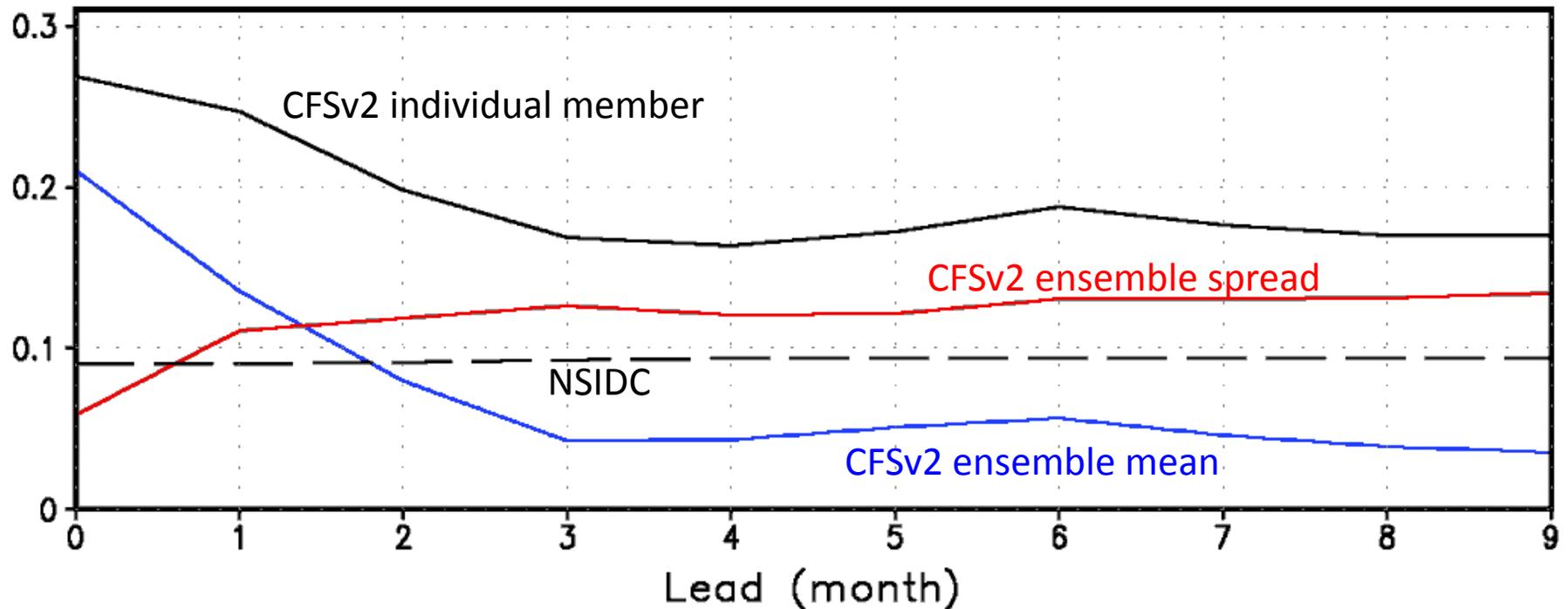
September



For September, too weak variability in CFSv2 may have resulted in an **overestimate** of predictability

Standard deviation and spread of Y2Y (10^6 km^2)

March



For March, too strong variability in CFSv2 may have resulted in an **underestimate** of predictability

Factors affecting the prediction and predictability

(1) Model errors

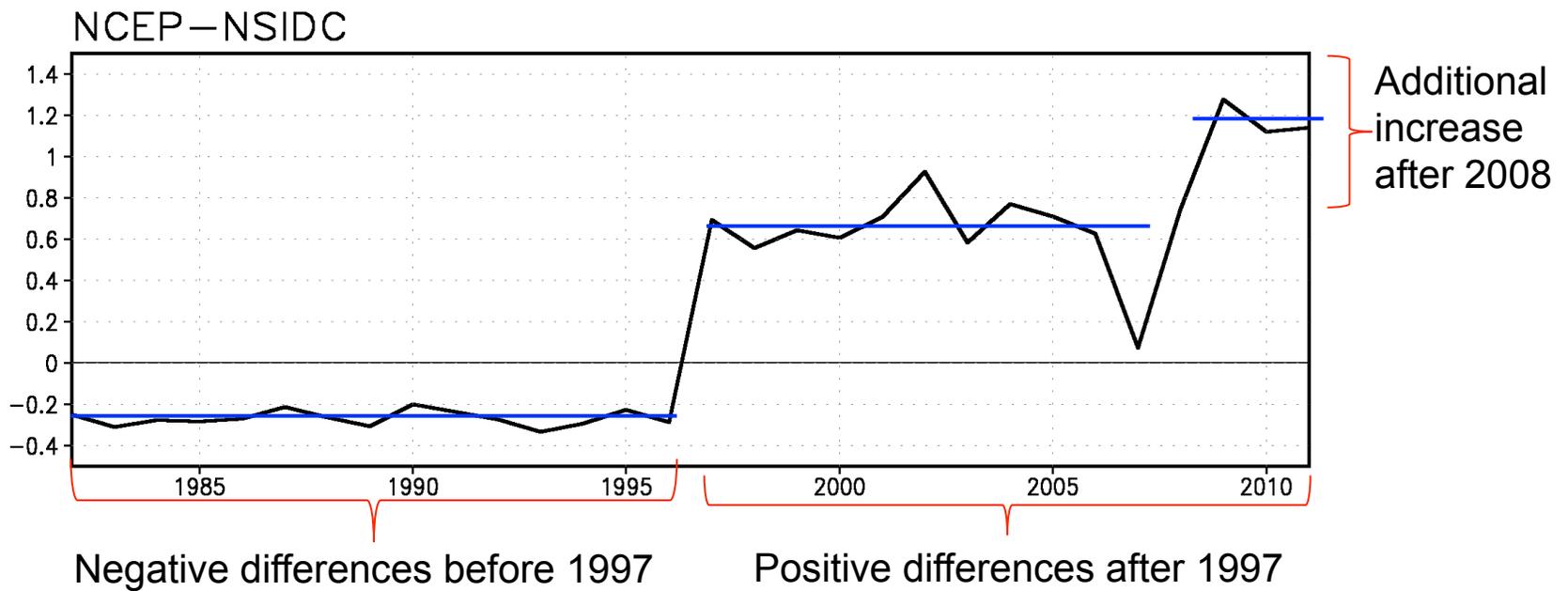
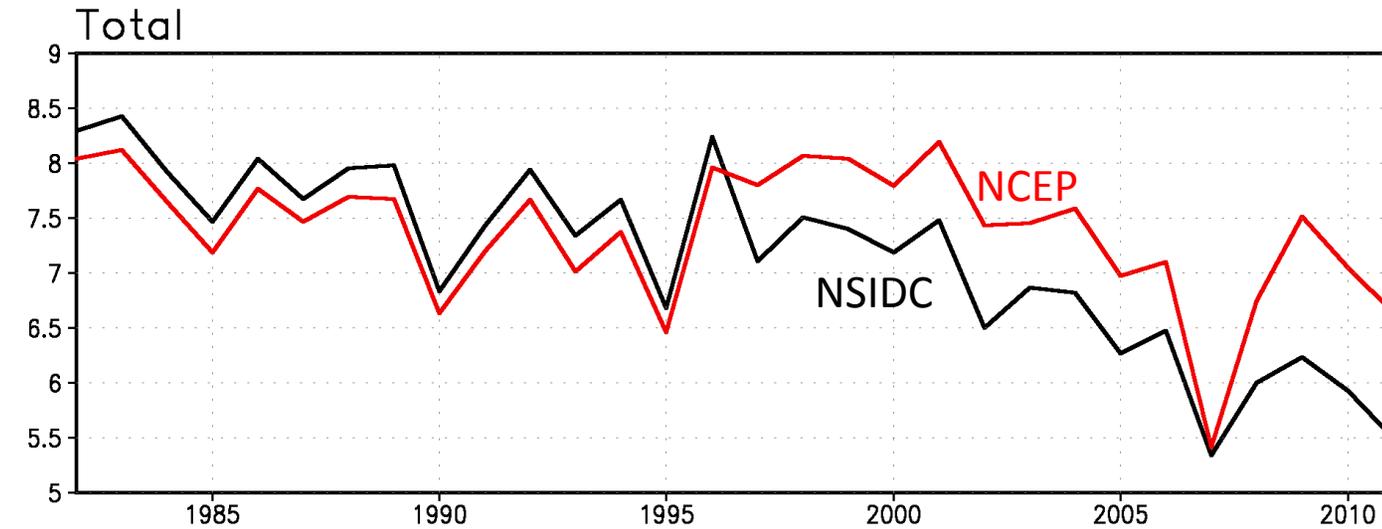
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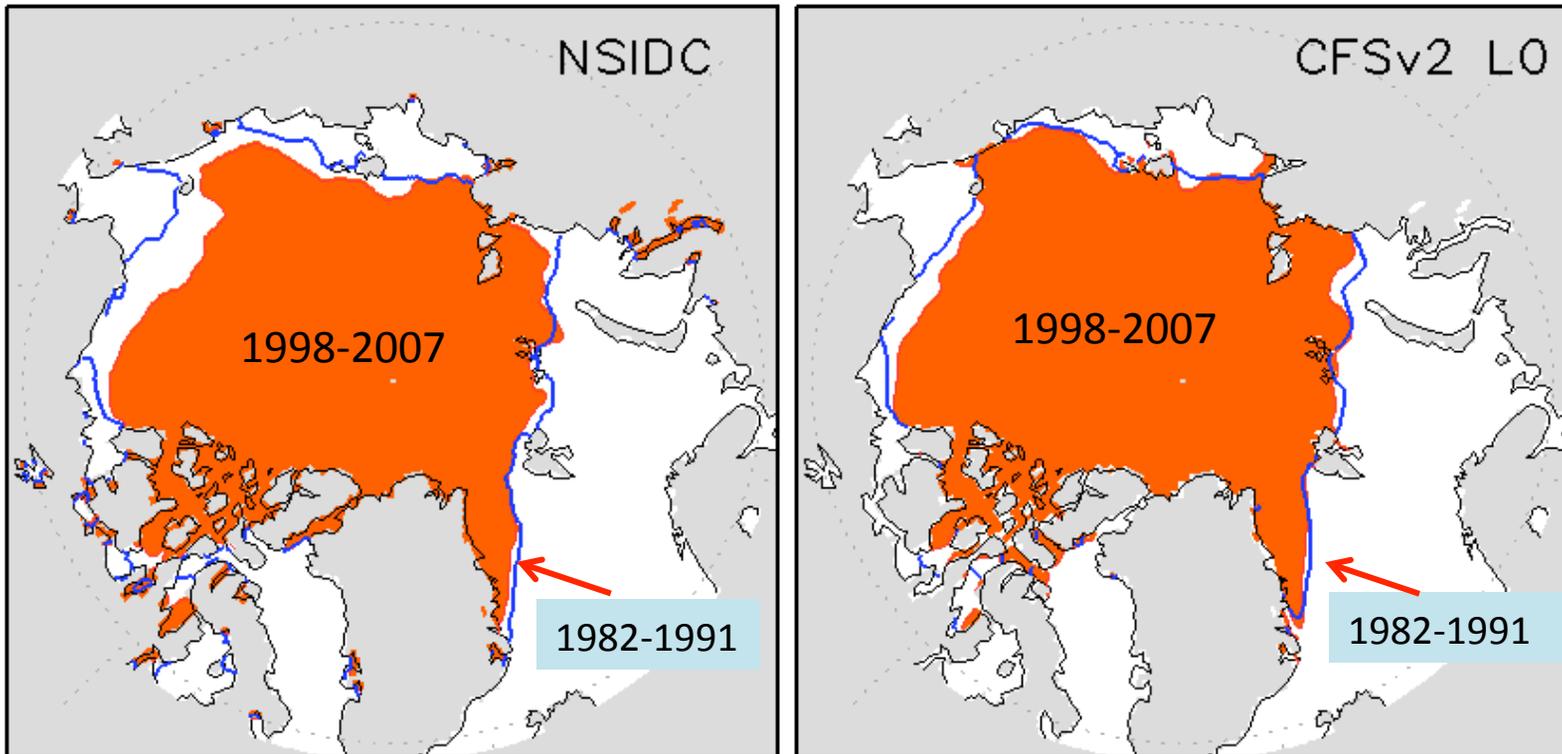
- i) Sea ice coverage
- ii) Sea ice thickness

Impacts of initial sea ice coverage

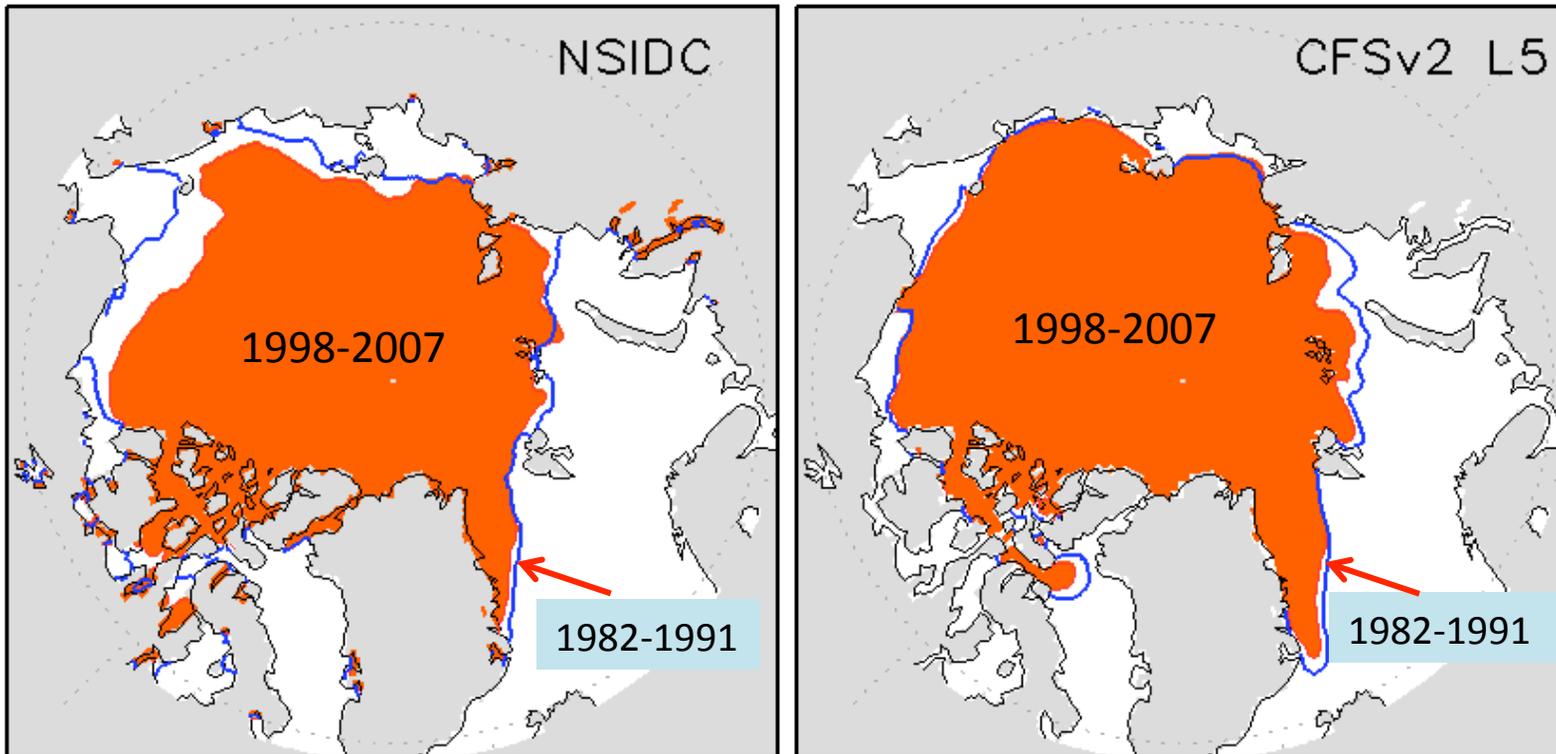
August sea ice extent anomalies (10^6 km^2)



September sea ice extent (10-year average)

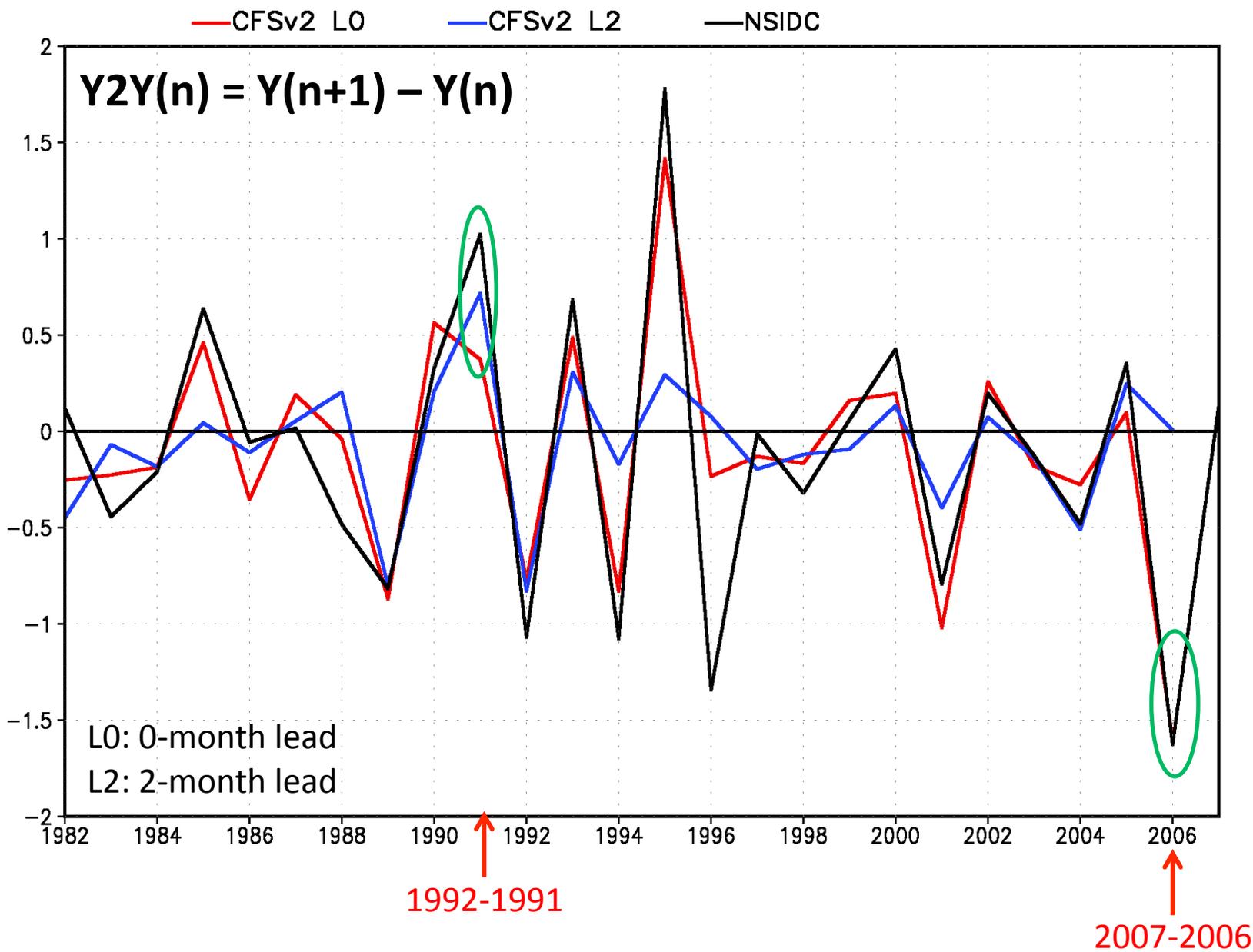


September sea ice extent (10-year average)

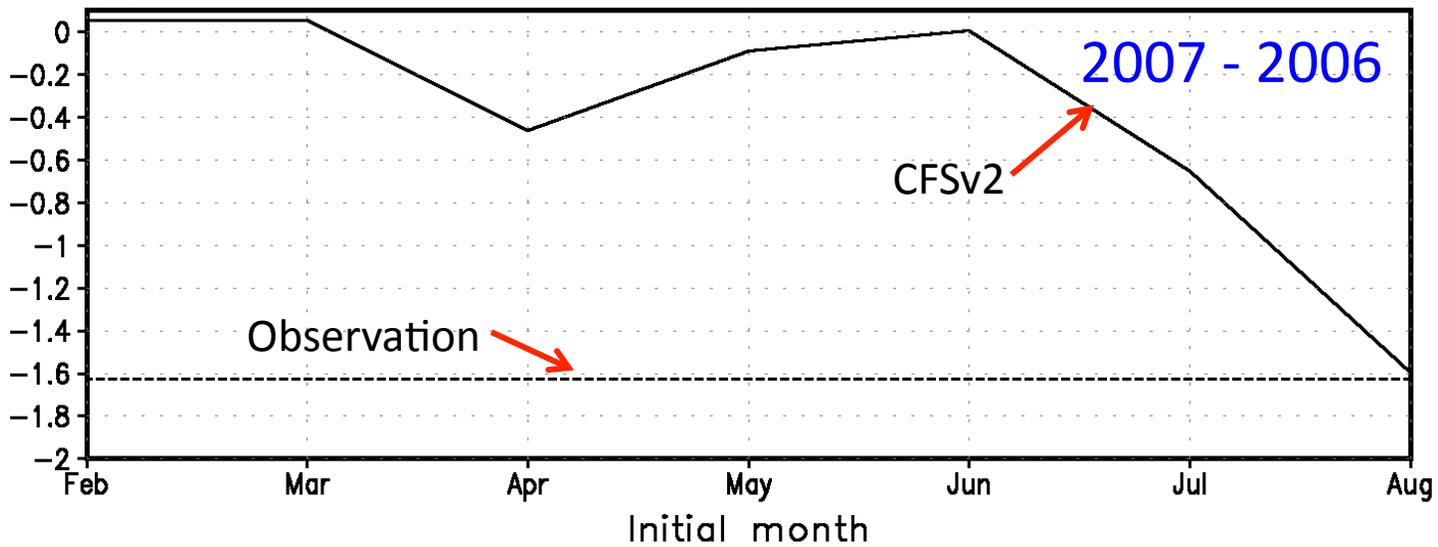
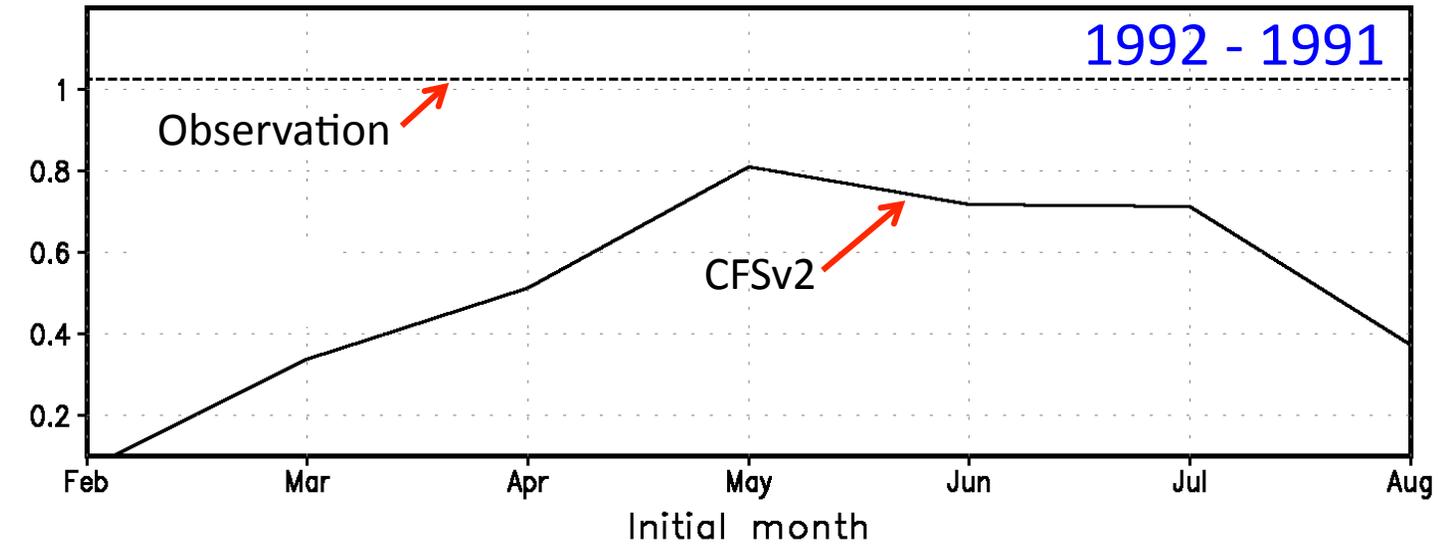


Impacts of initial sea ice thickness

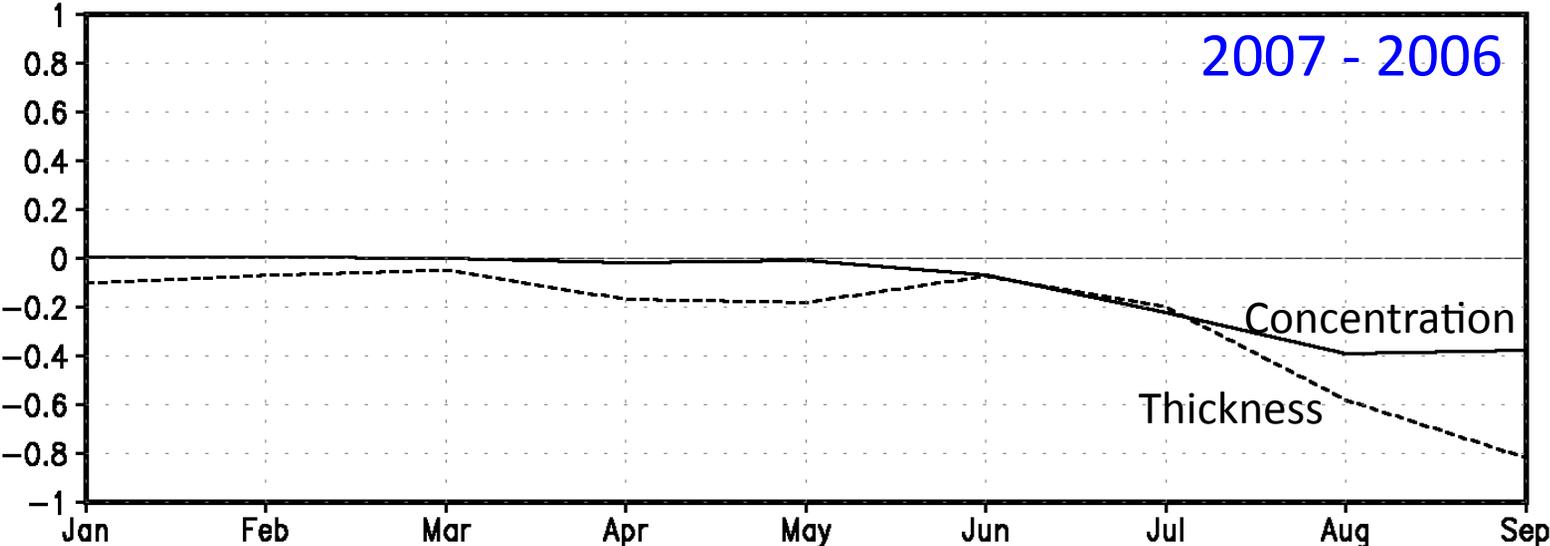
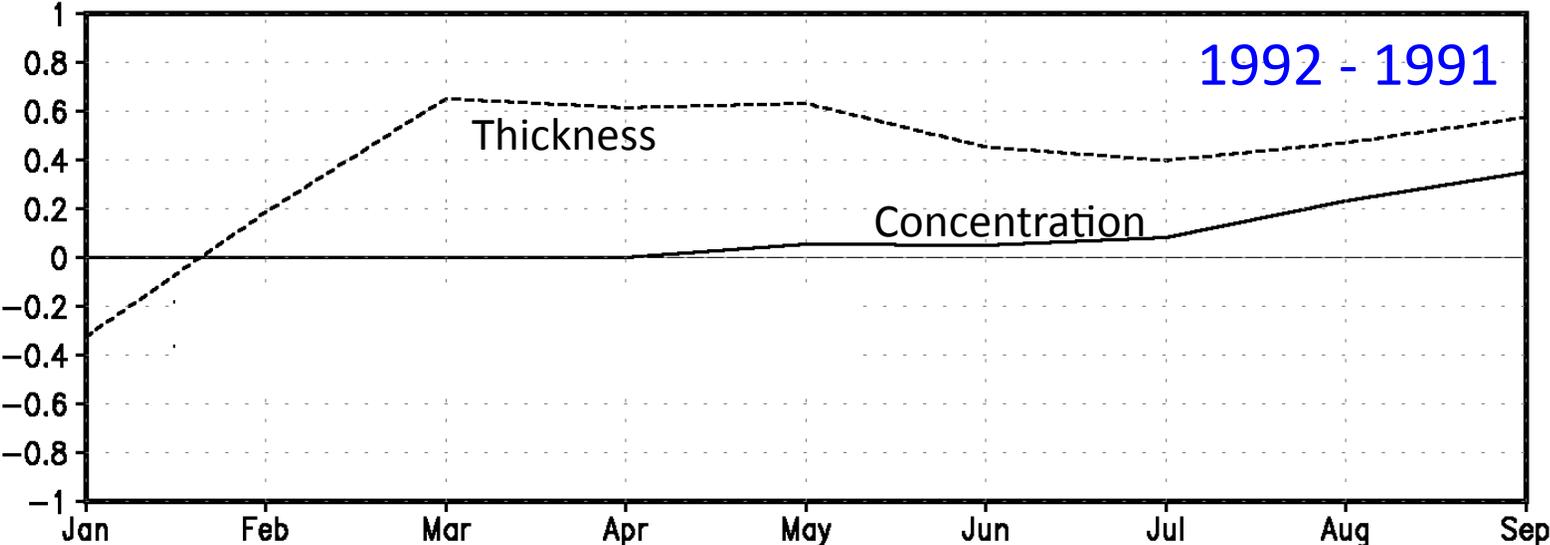
September sea ice extent anomalies (10^6 km^2)



September Y2Y (10^6 km^2)



CFSR sea ice concentration and thickness



Summary

- CFSv2 forecast contains mean SIE biases that vary with target seasons: Negative in Oct-Dec, and positive in other months. (Spatially, negative biases over Bering Strait, Hudson Bay and David Strait, and positive biases in Labrador Sea, Greenland Sea, Barents Sea.)
- CFSv2 underestimates long-term trend. Overall forecast skill for interannual variations is about two months.
- Improvements needed for a better sea ice prediction
 - i) Mean bias
 - ii) Representation of interannual variability
 - iii) Consistency of the sea ice initialization
 - iv) Accuracy of initial sea ice thickness